



# *Social Interaction*

## A VEHICLE FOR BUILDING MEANING

**T**wo project researchers worked collaboratively with ten Year 3–5 classroom teachers across nine schools in metropolitan and country regions of South Australia to answer the question: ‘What teaching strategies support all students to improve their numeracy outcome through the construction of meaningful understanding?’.

The research identified that there is no single aspect of teaching or no single environment feature that will, by itself, result in improved outcomes for all students. Rather, supporting students to think and work mathematically requires a combination of pre-arranged conditions and responsive teaching strategies. This paper will concentrate on just one of the findings: namely that learning is confirmed as not solely an active personal construction of knowledge, but is also influenced by the social environment in which it takes place. Interactions between teacher and student/s, and amongst students themselves, encouraged students to think, verbalise and analyse their own views of mathematical and numeracy concepts.

Test results at the end of the year were used to select three classrooms that showed greater growth in their mathematical understandings in linear measurement and area. Data from those classrooms were subsequently reanalysed and documented into a combined case analysis. Social interaction was identified as essential in supporting the development of understanding for all students. These interactions evolved within small groups or were orchestrated by the teachers as the students engaged with the mathematical activities. Both teacher-student interactions and student-student interactions supported students to construct their own meaning and built deeper understandings of mathematical concepts, as well as providing teachers with opportunities to find out about students’ understandings and prior knowledge of concepts.

**TRISH O’TOOLE and  
CHRISTELLE PLUMMER** from  
**Catholic Education South  
Australia** present findings  
from a state project designed  
to explore improved  
numeracy outcomes through  
teaching strategies that build  
understanding.

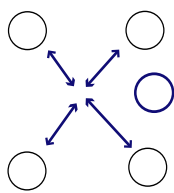
## Classroom interactions

In all three classrooms, a vital, underlying assumption was that all students could learn mathematics. Students were encouraged to work collaboratively: they were always seated in groups and were encouraged to interact and support each other. During the mathematical investigations students who needed assistance were required to ask other group members before seeking the teacher's support. Even when students discussed and shared ideas in groups they were still required to record their understandings in their own way in their own books.

Some of the interactions involved conferencing between a teacher and a student or a small group of students. Conferencing took place in these classrooms in a non-threatening environment and an atmosphere of mutual trust, where the teacher respected the students' ideas and encouraged the students to use their prior and informal knowledge. Conferences orchestrated by the teacher played a crucial role in supporting and challenging students' thinking and provided a context for establishing common knowledge. They provided students with quality time with the teacher, either on an individual or small group basis. The conferences also provided the teacher with opportunities to focus on individual students' needs and understandings, in response to the different pathways students took when investigating and constructing knowledge around the same mathematical ideas.

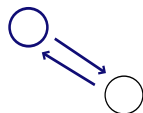
The interactions that emerged from the observations were classified into six categories, although not all of these categories were observed in all three classrooms. Categories 1, 2, 3 and 4 occurred as students worked co-independently and collaboratively during a mathematical experience.

### Category 1 Small group interaction with or without the teacher observing



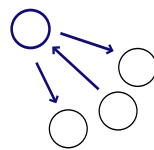
Students interacted with others, discussing strategies, making decisions and debating conflicting ideas. This type of interaction was not teacher initiated and the teacher was not invited into the discussion even when she came close by to observe.

### Category 2 One-to-one interaction (conference) between a student and the teacher



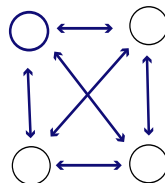
During a conference the student remained within the group while other group members continued with their work. This enabled the teacher to access the student's mathematical thinking, and to provide appropriate scaffolding to support the student towards desired results. Indirectly, this legitimised the position that there may be more than one way of solving the same problem, which could influence the development of flexible pathways in problem solving.

### Category 3 Small group interaction (conference) with the teacher directing the group



Sometimes the teacher conducted a conference with a group of students. In this case all members of the group took part in the discussion. In addition to the features described in category 2, the teacher used the interactions between students to support and challenge learning and to expose students to mathematical discussions and debate.

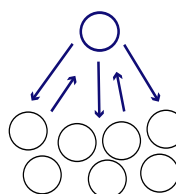
### Category 4 Small group with teacher interacting and observing at different times



In this interaction the students primarily controlled the dialogue. The teacher moved into the conversation when the students appeared to lose direction, or if she found the students required an additional challenge or support to link ideas, but left them to continue as a group when the discussion became more focussed in the anticipated direction.

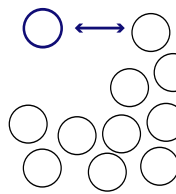
One of the three teachers involved students in whole class interactions (Categories 5 and 6) at the beginning and end of sessions. The other two teachers engaged students in whole class discussions at the beginning of a unit of work or at crucial stages during the unit of work.

### Category 5 Whole-class interaction with the teacher



Whole class interactions sometimes occurred at the beginning or at the end of sessions and involved the students and teacher in reflective discussions of the concepts associated with language, prior knowledge and possible strategies.

### Category 6 One-to-one public conference in a whole-class setting



Public conferences occurred between the teacher and one student. Several students usually took turns to share strategies and explain their work to the rest of the class. The teacher facilitated the sharing by asking probing questions, encouraging reflections by both the student sharing the strategies and the rest of the class.

## Teachers' use of questions to scaffold thinking

Effective questioning was identified as one of the significant features of the interactions. The questions the teachers were using were analysed and categorised according to the possible effect they may have had on students' learning. They included:

- *reconnaissance questions* — encouraging students to reflect and explain current reasoning;
- *linking questions* — supporting students to link their own informal language and ideas with the conventional mathematical ideas and associated terminology;
- *challenging questions* — refining and building onto mathematical thinking and strategies; and
- *supporting questions* — supporting the conceptualisation of the mathematical processes.

Examples of questions are now given from the teachers Tania and Sylvia.

### Reconnaissance questions: Reflecting and explaining current reasoning

Reconnaissance questions encouraged students to reflect and verbalise their thinking. The information gained from these questions provided the teacher with knowledge of the students' current understanding and were used by the teacher to inform the direction and focus of the teacher's ongoing facilitation for individual students' learning. In the following example, Tania observed Sam comparing shapes by collecting data on their area. Sam did not include the parts.

- Tania: So I see you are counting only the whole squares inside the triangle.
- Sam: Yes.
- Tania: Why not the parts?
- Sam: Are they necessary?
- Tania: Well, are they part of the area?
- Sam: Yes.
- Tania: So do they need to be counted as a measure of the area?
- Sam: Yes, I will have to cut them out and slice them up into whole squares

Questioning by the teacher required the student to explain his reasoning and understanding of the mathematical concept and strategies. Having to provide an explanation or a justification engages students in reflecting on the mathematical ideas and strategies, hence making them aware of the mathematical knowledge they are learning or investigating and how this knowledge relates to other ideas (reflection).

### Linking questions

The linking questions assisted students to connect their existing knowledge to the mathematical concept being investigated or to the problem they were attempting to solve. In this example, Gabby had collected data from a range of strips cut to different lengths, including fractions of a metre. All lengths were in multiples of 10 centimetres. Gabby had measured and recorded the measures in centimetres, except for the strip that was one metre. Sylvia challenged Gabby to convert her measurements to metres.

- Sylvia: I noticed that you have recorded all your data in centimetres. Is there another unit you could record them in? For example how would your numbers change if you recorded them in metres?
- Gabby: It's still 60 cm.
- Sylvia: So how would you record that in metres?
- Gabby: But the strips are not whole metres.
- [Sylvia leaves Gabby to think about it. Five minutes later, Gabby calls to Sylvia.]
- Gabby: I know 25 cm is a quarter of a metre.
- Sylvia: If 25 cm is a quarter of a metre how would the metre strip be described as a fraction?
- Gabby: 100/100 is a whole
- Sylvia: What do you think this might be? [pointing to 80 cm strip next to metre ruler]
- Gabby: [measuring the strip] It's 80. Oh! 80 over 100.

Sylvia left Gabby to continue her investigation with the intention of taking Gabby's thinking onto decimal fractions in the future.

Following Gabby's utterance, 'twenty-five centimetres is a quarter of a metre,' Sylvia's next set of questions, supported Gabby in making the connections in working out the relationships. Sylvia's questions encouraged Gabby to recall and use her prior and informal knowledge of fractions to further explore the relationship between centimetre and metre.

### Challenging questions

These questions were derived from something a student had said or recorded and often took the form: if this is so, can that possibly be true? These questions encouraged students to reflect on their data, refining and building onto their mathematical thinking and strategies, and using it as a basis from which to draw conclusions or to review their strategies. For example,

If this is 10 mm can this possibly be 90 mm?

Before you thought it was a half a unit. If it is not  $\frac{1}{2}$  mm then what unit would it be half of?

What would happen if you tried to compare an area measured in triangles with an area measured in squares?

If you think the length of this edge is nearly 4 metres long, how can this one be two metres long?

So does that work for all rectangles? Will it work for other shapes? Why? Why not?

In all of these questions it seems that the teachers were trying to encourage the students to think logically as a basis for the development of deductive reasoning. Working from the students' data, the teachers selected the information they determined as useful and correct to challenge the students' thinking. These questions followed the style: if this is known and correct, can that possibly be correct? Following are examples of these types of questions.

If you could solve it how do you think you would work it out?

Would that be the quickest way of doing it? What would be quicker?

So is there another way you could work it out?

These questions were posed either to individuals in a small group or to the whole class. They appeared to promote discussion about strategies and allowed students to make links between their preferred strategies and those of others, or to move to more sophisticated and conventional strategies. Questions in this instance seemed to remove the pressure of having to provide a correct answer and, in doing so, allowed the students to think and speak more freely. The teachers used this type of question when students were unsure how to answer or begin an investigation

## Supporting conceptualisation of the mathematical processes

Questions were also used to support the students in their collection and organisation of data, and to facilitate pattern searching in an attempt to build mathematical understanding and reasoning. The following are typical examples of questions that Sylvia used when supporting students in making sense of their data.

What types of information have you collected?

Do you think a table might help to organise your data so you can more easily search and identify a pattern?

So how many columns and what would the headings be for your columns?

Can you notice a pattern or relationship in your data?

Although the teachers' questions have been categorised into different groups these questions are interrelated and together provide a supportive framework. This framework encouraged the students to work from their informal knowledge and language and then to link it to the conventional mathematics. Through different types of questions the teacher created a reflective learning environment, which supported students towards the building of mathematical thinking and common shared understanding.

We would like to acknowledge the teachers, students, principals and school communities for allowing us to carry out the research.

**APMC**